COMPRESSION TEST OF BUILT-UP C SECTION COLD-FORMED STEEL WITH OPENINGS

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Kajian ini bertujuan untuk menentukan beban muktamad bagi bahagian C yang terbina terbentuk sejuk dengan bukaan berbanding dengan bahagian C tunggal dan mengkaji tingkah laku lengkokan mod kegagalan bahagian C yang terbina. Keluli terbentuk sejuk digunakan secara meluas dalam industri pembinaan, teknologi pembuatan dan piawaian yang berkaitan. Keluli terbentuk sejuk boleh didapati secara meluas dengan perbezaan saiz dan bentuk. Bahagian keluli terbentuk sejuk dibuat dengan proses yang berbeza seperti pembentukan gulung sejuk dan operasi tekan brek. Dalam ujian mampatan, pemuat mampatan telah dikenakan pada lajur pendek yang telah ditetapkan dengan siri pembukaan. Terdapat 8 model yang dijalankan untuk mendapatkan hasil yang tepat untuk menunjukkan kelakuan dan kekuatan keluli terbentuk sejuk. Tiang terbina terdiri daripada dua saluran keluli terbentuk sejuk yang diletakkan di belakang dan disambungkan di web menggunakan dua pengikat skru penggerudian sendiri pada jarak yang ditetapkan sepanjang tiang. Kedua-dua hujung setiap tiang akan dikimpal dengan plat keluli untuk bertindak sebagai sokongan tetap. Kajian ini membentangkan penerangan yang terperinci mengenai kajian percubaan dan teori untuk menyiasat beban maksimum dan tingkah laku lengkokan mod kegagalan bagi tiang keluli terbentuk sejuk. Mod kegagalan terbahagi kepada 4 categori iaitu lengkokan tempatan, belitan, meleding dan lengkokan lenturan. Semua model dalam bukaan memberikan data yang berbeza. Model tanpa bukaan memberi beban maksimum lebih tinggi berbanding model dengan bukaan. Penggunaan transducer dalam ujian mampatan juga memberikan tanda awal bagaimana struktur lajur berkelakuan di bawah beban paksi.

ABSTRACT

This paper aims to determine the ultimate load of built-up C section cold-formed steel with openings compared to single C section and study the buckling behavior of built-up C section. Cold-formed steels are widely used in construction industry, manufacturing technologies and relevant standards. Cold-formed steels are widely available with difference sizes and shapes. Cold-formed steel sections are manufactured with difference process such as cold roll forming and press brake operation. In the tests, compression loading were imposed on fix ended short columns with opening series. There are total of 8 specimens was conducted as to get an accurate result to show the behavior and strength of built-up cold-formed steel. The built-up column consists of two individual cold-formed steel lipped channels placed back-to-back and connected at the web using two self-drilling screw fasteners at specified spacing along the column length. Both end of each columns will be welded with a steel plate to act as fixed support. This paper presents a detailed descriptions of an experimental and theoretical studies to investigate the maximum load and buckling behavior of cold-formed steel columns. Mode of failure split into four categories such as local buckling, distortional buckling, warping and flexural buckling. All of specimen in openings give different data. Specimen without opening give more higher maximum load compare to specimen with opening. The use of transducer in the compression test gives the earlier sign how column structures behave under axial load.

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LIST OF ABBREVIATIONS

CFS	Cold-Formed Steel
FE	Finite Element
FKASA	Fakulti Kejuruteraan Awam dan Sumber Alam
UTM	Universal Testing Machine
AISI	American Iron and Steel Institute
JIS	Japanese Industrial Standard
SPCC	Steel Plate Cold Rolled Common
BC	Built-up C
SC	Single C
DB	Distortional Bottom
DBB	Distortional Bottom Back
DTB	Distortional Top Bottom
DTF	Distortional Top Front
DMB	Distortional Middle Back
DMF	Distortional Middle Front
LM	Local Middle
LT	Local Top
LBF	Local Bottom Front
LBW	Local Bottom Web
LTF	Local Top Front
WBB	Web Bottom Back
WBF	Web Bottom Front
WMF	Web Middle Front

CHAPTER 1

INTRODUCTION

1.1 Introduction

Cold-formed steel has been recently brought into Malaysia construction. The use of this structures is expanding quickly around the world due to the many approach in construction and manufacturing technologies and relevant standards. It is a steelwork innovation that has high potential to be developed in Malaysia, that can offer advantages such as fast erection, lightness of weight, clean and easier construction. Cold-formed steel structure is widely available with difference sizes and shape. Cold-formed steel members usually have symmetrical cross-sections, higher of strength and better resistance out-of-plane resistance.

In addition, cold-formed steel is a steel product that is formed by a steel strip or sheet of uniform thickness, in cold state. It is regarded as steel strip with uniform profile along its length and it is usually used in load bearing application. The use of cold-formed steel section can be found in automobile industry, shipbuilding, rail transport and construction industry. In building construction, the cold-formed steel is utilised in both structural and non-structural. As non-structural members, the advantages are more on rust resistance and aesthetic purposes. Figure 1.1 shows the building that used cold-formed steel sections. Cold-formed steel is a thin walled section and it is available with different sizes and shapes. It provided with holes to accommodate plumbing, electrical, and heating conduits in the walls and ceilings of buildings. The thicknesses of material for thin wall sections usually range from 0.373 mm to 6.35 mm. One of the best ways to perform this study is to connect two single members together to form a built-up I section.

Figure 1.1 Building composed entirely of cold-formed steel sections

Source: (Specifying cold-formed steel to meet project goals - Construction Specifier, 2017)

Next, for built-up section, it has symmetric cross sections, higher strength and better resistance against out-of-plane. It is easily failed in overall buckling, if not laterally supported. A built-up section can spend more distance, higher torsional; stiffness and higher load bearing capacity. Therefore, the use of built-up sections can be a major advantage of economic since the whole manufacture process remains the same. When structure section modified with opening, it will be represented in thin-walled structural members to facilitate access for services and inspection. It will obviously result in changes in stress distribution within the member. A reduction of strength and variations in the buckling characteristics of the plate elements.

In building construction, there are primarily two types of structural members: hot rolled steel shapes and cold rolled steel shapes. Cold-formed steel shapes are formed at room temperature while hot rolled steel shapes are formed at elevated temperatures. Cold-formed steels are made from structural quality sheet steel and formed into shape, either

through press braking blanks sheared from sheet or coils by rolling forming the steel through a series of dies. Due to the relative method of manufacturing process, a large number of different compositions can be produces to fit the demands of optimized for both structural and economical purposes.

1.2 Problem Statement

Cold-formed steel can be productive in many applications where conventional hot rolled steel proves uneconomic. Cold-formed steel is a thinner material compared to the other type of hot rolled steel. The buckling stability will be different compared to conventional structural steel. When it is thin and lightweight, the strength not strong than hot rolled steel. Effect strength of cold-formed steel due to position of opening also need to be taken because the difference behaviour of failure mode occurs when different position of opening. Next, the stiffener is commonly used in cold-formed steel section to provide a continuous support along a longitudinal edge of flange to increase the buckling stress. It can be easily brake pressed on the free edge of an unstiffened plate. Further, the stiffeners also may transform considerably their distortional buckling, post buckling and collapse behaviour.

In most past researches, cold-formed steel built-up sections as cold-formed C face-to-face (Figure 1.2(a)) and nested section (Figure 1.2(c)), were studied. In building construction, cold-formed steel C back-to-back sections (Figure 1.2(b)) were applied. However, there are few researches on this type of built-up section. Since the torsional is much smaller than the C face-to-face section, more detailed investigation on buckling behaviour of the C back-to-back section is needed.

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